This application, as amended herein, contains claims 1-16. Claims 1-4, 8 and 16 were rejected as being unpatentable over Tjandrasuwita in view of Kim and the newly cited patent to Asprey. Claim 5 was rejected as being unpatentable over Tjandrasuwita in view of Asprey. Claims 6 and 7 were rejected as unpatentable over Tjandrasuwita and Asprey in view of Kim. Further, claims 9-10, and 12-13 were rejected as being unpatentable over Tjandrasuwita in view of Larkin et al. and Asprey. Finally, claims 11, and 14-15 were rejected as unpatentable over Tjandrasuwita, Larkin et al. and Asprey, in view of Kim. These rejections are respectfully traversed.

As note in the previous Amendment, Applicants' invention is directed to a concept not shown or suggested in the prior art. Specifically, the number of gray levels, which are displayed on a liquid crystal display can be increased dramatically without applying any optical arrangements such as filters to the surface of the liquid crystal display or increasing the number of bits provided by the driver of the liquid crystal display. This is done by selectively shifting the gray levels of at least one sub-pixel with respect to those of another sub-pixel. The results is that when the pixel is viewed, the number of gray levels that can be displayed is greatly increased. The prior art does not teach or suggest this approach. Further, as noted below, this approach may be implemented so that no multiple of a brightness level of an intermediate gray level of the sub-pixel is identical to a brightness level

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intermediate gray level of another sub-pixel. This also serves to assist in dramatically increasing the number of gray levels that may be displayed, without significant additions to the complexity and cost of the drivers.

Applicants' invention, as set forth in claim 1 as amended herein, includes a memory for storing information about an offset for converting gray level coordinates of a gamma characteristic spaced evenly according to the number of bits into gray level coordinates spaced unevenly, so that the gray level coordinates of least one sub-pixel are between the gray level coordinates of another sub-pixel. Claim 1 further includes a gray level adjustment portion for performing a calculation on particular input sub-pixel data based on information about the offset stored in the memory. A pseudo gray level expansion portion applies pseudo gray level expansion to the sub-pixel data calculated by the gray level adjustment portion. The sub-pixel data to which the pseudo gray level expansion is applied by the pseudo gray level expansion portion is supplied to the liquid crystal driver to display the image on the liquid crystal cell. The result is that the number of gray scale levels which can be displayed is increased. Significantly, it is noted that claim 1 has been amended herein to state that the gray levels coordinates of at least one sub-pixel are <u>spaced at a higher density</u> between the gray level coordinates of another sub-pixel.

Neither Tjandrasuwita nor Kim nor Asprey, whether taken alone, or in combination, teach or suggest Applicants' invention as set forth in claim 1. While both

Tjandrasuwita and Kim are concerned with the manipulation of gray scale levels, neither teachers or suggest that the number of gray scale levels displayed may be greatly increased by ensuring that the gray level coordinates of at least one sub-pixel are between the gray level coordinates of another sub-pixel, and that that the gray levels coordinates of at least one sub-pixel are spaced at a higher density between the gray level coordinates of another sub-pixel. In fact, because the drivers provide equal voltage steps, while the displays do not display intensity linearly with voltage, Kim is concerned with being sure that there is gamma correction so that pixels accurately display intensity. Shifting the level of sub-pixels would not serve to solve the problem that Kim addresses, and in fact in that sense, Kim actually teaches away from the present invention. In view of the above, and in view of the advantages noted for Applicants' invention of providing greatly enhanced gray scale level display, while not unduly increasing the complexity and cost of the hardware required, it is submitted that Applicants' invention, as set forth in claim 1, is directed to patentable subject matter.

Applicants' invention, as set forth in independent claim 5, is directed to a monochrome liquid crystal display apparatus including a controller for outputting, from input monochrome data in which one pixel is represented with a plurality of sub-pixels, a gray level set for each of the plurality of sub-pixels. A liquid crystal driver supplies a voltage to the liquid crystal cell based on a gray level of the plurality of sub-pixels output from the controller,

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without varying the liquid crystal transmittance for a particular gray level among the plurality of sub pixels. Further, the controller assumes a characteristic for the particular sub-pixel in which no multiple of the brightness level of any intermediate gray level is identical to the brightness level of any intermediate gray level of another sub-pixel, and selects a gray level which provides desired brightness from within the characteristic. Finally, claim 5 has been amended to state that a density of gray levels for at least one of the sub-pixels is greater than that of another of the sub-pixels.

Thus, Applicants' invention, as set forth in claim 5, has several features not shown or suggested by Tjandrasuwita or Asprey, whether taken alone or in combination. First the liquid crystal transmittance for a particular gray level among the plurality of sub-pixels is not varied. In addition, no multiple of the brightness level of any intermediate gray level is identical to the brightness level of any intermediate gray level of another sub-pixel. In addition, a density of gray levels for at least one of the sub-pixels is greater than that of another of the sub-pixels. It is respectfully submitted that the Examiner, completely misses the point that there is no teaching or suggestion in the cited referneces, that by following the approach of claim 5, the number of gray scale levels that can be displayed will be greatly increased. Thus, Applicants' invention, as set forth in claim 5 is not a mere obvious extension of the teachings of Tjandrasuwita and Asprey. To the contrary, it provides the advantages noted above of increasing the number of displayed levels

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without requiring more costly and complex drivers, with more output bits. Thus, it is respectfully submitted that claim 5 is clearly directed to patentable subject matter.

Claims 6, which depend from claim 5, further defines Applicants' invention by noting that the controller uses a gray level which fills the space between coordinates of gray levels spaced evenly on a given gamma characteristic curve to output the gray level at the plurality of sub-pixels. Here again, by offsetting the intensity levels of some sub-pixels with respect to other sub-pixels, the number of gray scale levels which can be displayed is increased. Thus, it is respectfully submitted that claim 6 is also directed to patentable subject matter.

Claims 7 recites that the controller outputs a gray level by using the given gamma characteristic for a given sub-pixel of the plurality of sub-pixels and outputs a gray level based on a different gamma characteristic for other sub-pixels. Again, there is no teaching or suggestion in the prior art that one should use a different gamma curve for different sub-pixels to increase the number of gray scale levels that can be displayed. In fact, unless one specifically had in mind Applicants' invention, there would be no reason whatsoever for doing this, as it would not aid in the accurate display of an image. Thus, it is respectfully submitted that in finding Applicants' invention, as set forth in claim 7 obvious, the Examiner is using impermissible hindsight, and this is not permitted. Thus, it is respectfully submitted that claim 7 is directed to patentable subject matter.

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Claim 8, as amended herein, is directed to a controller for providing image data for each of a plurality of sub-pixels to a liquid crystal driver supplying a voltage to a liquid crystal cell by inputting data in which one pixel is represented by a plurality of sub-pixels comprising a memory for storing information about an offset for converting gray level coordinates of a gamma characteristic spaced evenly according to the number of bits of the liquid crystal driver into gray level coordinates spaced unevenly. The gray level coordinates spaced unevenly represent additional intensity levels to be displayed, and are at a higher density. The prior art does not teach or suggest this approach to displaying additional gray levels. Quite to the contrary, Kim teaches how to provide gray levels that are spaced evenly despite the non-linearity of the gamma curve. In sharp contrast, the present invention, as set forth in claim 8, provides gray level coordinates that are spaced unevenly so that a greater number of intensity levels may be displayed. This is exactly the opposite of what Kim seeks to do and thus Kim, even when combined with Tjandrasuwita and Asprey teaches away from the present invention as set forth in claim 8. Thus, it is respectfully submitted that claim 8 is directed to patentable subject matter.

Claim 9, as amended herein, is directed to an image conversion method. Among the other recitations, claimed 9 recites: replacing said sub-pixel data with an appropriate gray level which provides a desired brightness selected from a higher density gray levels than a gray level representable with the number of bits in the liquid crystal driver in order to applying different gamma characteristics to each of the

plurality of sub-pixels, so as to increase the number of intensity levels displayed. Again, it is respectfully submitted that the Examiner has missed the point. The Examiner notes that the approach of Asprey may be used in order to increase the number of intensity levels by combining an optimum shade of gray for each combination of R, G and B signals which produce a discrete shade of gray different of background shade of gray. However, the problem of differentiating from background of Asprey has nothing whatsoever to do with increasing the number of intensity levels displayed, so as to be able to obtain better resolution, by applying different gamma characteristics to each of the plurality of sub-pixels as specifically recited in claim 9. Thus, it is respectfully submitted that claim 9 is also patentable over the art of record.

Claim 11, which depends from claim 9, recites that the replacing step replaces the sub-pixel data with an appropriate gray level by using a gray level filling the space between any gray levels of a basic gamma characteristic set based on the number of bits. Again, it is pointed out that the combination of references cited provides no teaching or suggestion of increasing the number of gray levels displayed. Thus it is respectfully submitted that claim 11 is patentable over any combination of Tjandrauwita and Larkin et al. and Asprey.

Claim 12 is directed to an image conversion method which includes steps of inputting a plurality of pieces of sub-pixel image data, each of the pieces of sub-pixel image data comprising N bits. Claim 12 also recites: assuming a second gamma characteristic corresponding to M bits (M>N) which is provided by adjusting a first gamma characteristic corresponding to N bits, at least a portion of said M bits

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representing gray levels <u>at a higher density</u> between gray levels represented by said N bits. Thus, the method of claim 12 provides the opportunity of displaying additional gray levels. Neither Tjandrawita nor Larkin at al. nor Asprey teach or suggest that at least a portion of a greater number of bits can be used to represent gray levels for purposes of displaying these additional levels at a higher density level. It is thus respectfully submitted that claim 12 is also directed to patentable subject matter.

Claim 13 is a method claim, which includes the recitation of assuming a gamma characteristic of said sub-pixels in which no multiple of a brightness level of an intermediate gray level of the sub-pixel is identical to a brightness level of any intermediate gray level of another sub-pixel<u>, and wherein a density of gray levels for at least one of said sub-pixels is greater than that of another of said sub-pixels</u>. As noted above with respect to apparatus claim 5, this provides the opportunity of greatly increasing the number of gray scale intensity levels that can be displayed. For the reasons set forth above with respect to claim 5, it is respectfully submitted and that claim 13 is also patentable over the art of record.

Claims 14 and 15, which are dependent directly or indirectly from claim 13, positively recite the use of a higher density of gray levels. For the reasons set forth above with respect to claim 13, it is respectfully submitted that these implementation of the method of claim 13 are not shown or suggested in the art of record, and so therefore also are directed to patentable subject matter.

Claim 16, which depends from claim 1, specifies that no multiple of a brightness level of an intermediate gray level of one sub-pixel is identical to a brightness level of any intermediate gray level of another sub-pixel. Thus, claim 16 combines features of claim 5, the advantages of which were discussed in detail above, with the features of claim 1. For the reasons set forth above for both claim 1 and for claim 5, it is submitted that newly added claim 16 is also directed to patentable subject matter.

The remaining dependent claims not discussed above have further recitations, which in combination with the recitations in the claim from which they depend, are not shown or suggested in the art of record. For the reasons set forth above with respect to the independent claims, it is respectfully submitted that these dependent claims are also directed to patentable subject matter.

In view of the allowable nature of the subject matter of all of the claims, if the Examiner cannot issue an immediate allowance, it is respectfully requested that he contact the undersigned to resolve any remaining issues.

Applicants respectfully petition for an extension of time of one month for submission of this paper. A check in the amount of $110 to cover the extension of time is submitted herewith.

Respectfully submitted,

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3/24/2004
Date

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